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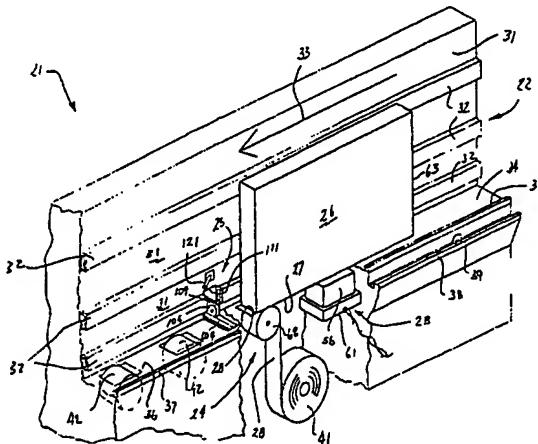
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(54) Title: EDGE BANDING APPARATUS AND METHOD



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(57) Abstract: An edge banding apparatus (21) for adhesively securing banding material (28) to an edge of a board (27). The apparatus (21) includes a board support structure (22) formed to support a board (26) in a near vertical orientation with the edge (27) to be banded in a downwardly facing orientation. An adhesive applying assembly (23) is positioned relative to the board support structure (22) and is formed to apply adhesive (54) to the downwardly facing edge (27) during relative motion between the board (26) and the adhesive applying assembly (23). The apparatus (21) includes a banding material applying assembly (24) positioned downstream of the adhesive applying assembly (23) and formed to apply a banding material (28) to the edge after the adhesive (54) is applied and a cutoff assembly (25) which cuts off the banding material (28) as the banded board (26) passes the cutoff device (25). Pneumatic adhesive level sensing assembly (71) and a pneumatic adhesive refilling assembly are both disclosed, as is a method of edge banding a board (26).

EDGE BANDING APPARATUS AND METHOD

TECHNICAL FIELD

5 The present invention relates, in general, to apparatus for adhesively securing veneer or banding material to boards and panels, and more particularly, relates to an apparatus and method for adhesively securing banding material strips to the edges of a board or panel.

BACKGROUND ART

10 In many furniture applications, boards or panels, and particularly veneer-covered boards and panels, have an edge strip of banding material secured to the edges of the board or panel to prevent unsightly edges from being exposed in the final product. Typically such edge banding strips are adhesively secured, usually hot-glued, 15 to the board or panel edge by an edge banding apparatus or machine.

20 The board or panel may be a wooden member or a composite member and may, or may not, have a veneer layer on one of the front and/or back surfaces thereof. As used herein, however, the expression "board" shall include wooden and composite substrates, members, panels or boards, and may even include plastic substrates. Such "boards" may or may not include front and/or rear surface veneer layers on them.

5 Prior art edge banding apparatus typically are formed to support the board to be edge banded in a generally horizontal orientation. They include applicator assemblies which apply adhesive, usually hot adhesive, to a generally vertically oriented edge of the horizontal board from an adhesive reservoir having a heating element in the reservoir. Since the adhesives most commonly used must be heated to a very high temperature, for example, 10 200°C., handling of the hot adhesive is difficult and dangerous.

15 There are constant problems with hot adhesive slump or running off of the adhesive from the adhesive applicator and/or the board edge. Usually a roller or dispensing wheel mounted to rotate about an horizontal axis is used to apply the hot adhesive, and compensating for adhesive 20 slump can be difficult. Other adhesive handling problems arise when using prior edge banding equipment. Thus, changing adhesive colors and refilling the adhesive reservoir have both caused safety and time consumption problems.

25 Still further, such prior art edge horizontal banding devices have required considerable floor space, for example, in order to support a horizontally oriented 4 foot by 8 foot panel during edge banding. Panel or board handling using prior art apparatus also has not been very ergonomic, causing undue worker fatigue. Additionally, in wood-working or furniture manufacturing facilities, wood dust is a serious problem, and prior art edge banding apparatus have had many horizontal surfaces on 30 which dust and debris can accumulate.

Another problem encountered in prior art edge banding apparatus has been that the rough trim or banding material cutoff assembly has been either a scissors or guillotine type of device which can present a safety

hazard. These trim devices typically project a cutting blade through the direction of travel of the board to create a pinch point which cannot be well guarded.

5 Accordingly, it is an object of the present invention to provide an edge banding apparatus and method which is more ergonomic, has more uniform and reliable adhesive application, and is easier and safer to operate.

10 Another object of the present invention is to provide an edge banding apparatus which requires less floor space, has fewer horizontally oriented dust-collecting surfaces and employs the weight of the board being edged to enhance securement of the banding material to the board edge.

15 Still another object of the present invention is to provide an apparatus and method for sensing the level of adhesive in a relatively small adhesive reservoir for the edge banding apparatus and to periodically automatically refill the adhesive reservoir based upon the level sensed.

20 Another object of the present invention is to provide an adhesive applying assembly in which the adhesive reservoir and heating device are separable elements.

25 A further object of the present invention is to provide an improved adhesive dispensing assembly and method for dispensing adhesive in an edge banding apparatus.

It is also an object of the present invention to provide a banding material cutoff assembly or rough trim device which can cutoff the edge banding material without exposing the operator to a safety hazard.

5 The edge banding apparatus and method of the present invention have other objects and features of advantage which will be set forth in more detail in, or will be apparent from, the following Best Mode of Carrying Out the Invention and the accompanying drawing.

DISCLOSURE OF THE INVENTION

10 The edge banding apparatus of the present invention comprises, briefly, a board support structure formed to support a board to be edge-banded in a near vertical orientation with an edge of the board to be banded in a downwardly facing orientation, an adhesive applying assembly positioned relative to the board support structure and formed to apply adhesive to the downwardly facing edge during relative movement between the board and the adhesive applying assembly, and a banding material applying assembly formed to apply a banding material to the board edge after application of the adhesive and during relative movement between the board and the banding material applying assembly. In the 15 preferred embodiment the board is supported on the board support structure for movement of the board and downwardly facing edge over the top of a roller adhesive applicator and over the top of a banding material applying roller. Subsequent pressing rollers press the applied banding material against the adhesive on the board edge using the weight of the board to effect such pressing.

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30 In another aspect of the invention, a pneumatic sensing apparatus is provided to sense the level of viscous adhesive in an adhesive reservoir of the edge banding apparatus in order that the reservoir can be periodically refilled. Moreover, a pneumatically operated granular adhesive dispensing assembly is coupled to receive

signals from the level sensing apparatus in order to refill the adhesive reservoir.

The method of adhesively securing a banding material to the edge of a board of the present invention is comprised, briefly, of the steps of orienting the board to be edge-banded in a substantially vertical orientation with the edge to be banded facing downwardly, applying adhesive to the downwardly facing edge during relative movement between the board and an adhesive applicator, thereafter applying a banding material to the downwardly facing edge over the adhesive, and pressing the banding material against the edge, preferably by using, in part, the weight of the board against a pressing surface, such as pressing rollers.

15 Methods of pneumatic adhesive level sensing and pneumatic adhesive dispensing also are provided.

BRIEF DESCRIPTION OF THE DRAWING

FIGURE 1 is a top pictorial view, partially broken away, of a schematic representation of an edge banding apparatus constructed in accordance with the present invention.

FIGURE 2 is an end elevation view of the banding apparatus of FIGURE 1.

FIGURE 3 is an enlarged, top pictorial view of a schematic representation of an adhesive applicator assembly suitable for use in the edge banding apparatus of FIGURES 1 and 2, with a portion of the board support structure shown in phantom.

30 FIGURE 4 is an enlarged, side elevation view of a schematic representation of a portion of an adhesive

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dispensing assembly suitable for use in the edge banding apparatus of FIGURES 1 and 2.

5 FIGURE 5 is a fragmentary, top pictorial view of a schematic representation of a banding material cutoff assembly suitable for use in the edge banding apparatus of FIGURES 1 and 2.

BEST MODE OF CARRYING OUT THE INVENTION

10 Referring now to FIGURES 1 and 2, a preferred form of the edge banding apparatus, generally designated 21, of the present invention is illustrated. The present apparatus includes a board supporting structure, generally designated 22, an adhesive applying assembly, generally designated 23, a banding material applying assembly, generally designated 24, and a banding material cutoff assembly, generally designated 25. Assemblies 15 for performing these functions are all broadly known in the prior art and do not, per se, constitute a novel aspect of the present invention.

20 In banding apparatus 21, however, board support structure 22 is formed to support a board 26 in a new or different orientation, namely, in a substantially or near vertical orientation with an edge 27 of the board to be banded in a downwardly facing orientation for application of a banding material 28 thereto. In prior art edge banding apparatus, board 26 is supported by a board supporting structure which orients the board in a generally horizontal plane with the edge to be banded oriented in a near vertical plane. There are several disadvantages 25 from such a board orientation. One disadvantage of such prior art edge banding apparatus is that they require an undesirable amount of floor space. As can be seen in FIGURE 2, the width dimension, W, of edge banding apparatus 21 of the present invention can be relatively 30

narrow, for example, as compared to the height of board 26. If board 26 were supported on a horizontal surface, width dimension, W, of the banding apparatus would be much greater.

5 Another advantage of the present board support structure, which vertically orients the board 26, is that there is a substantial ergonomic advantage in terms of handling board or panel 26 in that the weight of the board, Wt., is oriented so as to press downwardly against the banding 10 material 28 to thereby insure that it is firmly secured to edge 27 of the board. The operator, of course, can manually apply additional downward pressure on board 26 in order to ensure that banding material 28 is firmly 15 pressed against the adhesive on edge 27. Additionally, vertical board supporting structure 22 presents fewer horizontally oriented surfaces on which the dust and airborne debris typically found in a wood working or 20 furniture manufacturing facility can collect. Finally, vertical orientation of board 26 by support structure 22 results in a more uniform and reliable application of adhesive to edge 27, in a manner which will be described below.

25 Board support structure 22 can take several forms, but in the preferred embodiment, a generally vertically oriented wall-like structure 31 is provided to which box channels or board-engaging member 32 can be secured. The channels space the board outwardly of the wall 31 so that the operator, standing facing wall 31 (the right 30 side of FIGURE 2), can manually grip the board and move it in the direction of arrow 33 along board support structure 22.

The board support structure also includes near horizontal surface 34 which supports edge 27 of board 26 in advance of adhesive applying assembly 23 and banding material

5 applying assembly 24. Such horizontal support continues at 36 downstream of the adhesive and band applying assemblies. It is preferred that a small flange or rail 37 extend upwardly at the outer edges of surfaces 34 and
10 36 over the length of these horizontal surfaces so that lower edge 27 of board 26 cannot slip outwardly toward the operator who is manipulating the board. Moreover, in the preferred embodiment, a second rail 38 and horizontal support surface 39 can be provided to enable
15 the operator to temporarily set the board on surface 39 prior to edge banding, for example, while replacing the roll 41 of banding material 28. The secondary support surface 39 can be provided over the full length of edge banding apparatus 21 or merely on the end upstream of the adhesive and banding applying assemblies.

20 As illustrated, edge banding apparatus 21 is designed for manual operation by a user who grips board 26 and slides it along support surfaces 32, 34 and 36 in the direction of arrow 33. It will be understood, however, that movement of board 26 also could be powered, for example, by providing powered rollers along the length of surfaces 34 and 36. In the illustrated version, there are pressing rollers 42 which extend above surface 36 to press banding material 28 against edge 27, but these
25 pressing rollers are shown as being passive or unpowered rollers. It would be a simple matter to power them and add similar drive rollers in surface 34 so that board 26 can be driven by the operator along the length of board support structure 22 of edge banding apparatus 21.
30 Moreover, powered or idler rollers also could be provided in wall support structure 31 instead of, or in addition to channels 32. Since there is little weight on channels 32, however, there is little frictional resistance to sliding of the board therealong, and rollers in wall 31
35 are not required for smooth movement of the board along board supporting structure 22.

Referring now to FIGURE 2, it will be seen that in the preferred form of the edge banding apparatus board support structure 22 is formed to tilt board 26 from a vertical plane 43 to a plane 44 by an amount sufficient to stabilize board 26 as it is moved along support structure 22 against falling toward the operator. Preferably, a tilt in the range of about 3° to about 10° toward the board supporting wall 31 provides sufficient stability for sliding movement of board 26 along support structure 22, while still maintaining most of the weight of the board oriented in a downward direction through edge 27. As the angle θ increases, the advantage of the board weight pressing edge banding material 28 against the applied glue and board edge diminishes, and the width dimension, W, of the assembly, as well as the number of horizontal surfaces, increases. The angle θ , however, could be as high as 30° without departing from the spirit and scope of the present invention, and the expression "near vertical," as used herein, shall include 60° to 90° from a horizontal plane.

One of the further important aspects of orienting board 26 in a generally vertical plane is that adhesive applying assembly 23 will more reliably and uniformly apply adhesive to edge 27. A roller applicator 51 (FIGURE 3) having an adhesive-applying peripheral surface 52 can be generally horizontally oriented with applicator roller 51 mounted for rotation about a generally horizontal axle 53. The roller, therefore, progressively rotates down through an adhesive 54 contained within an adhesive reservoir 56. As peripheral surface 52 rolls upwardly from adhesive 54 it carries adhesive 54 on surface 52, which rollingly engages edge 27 of board 26 so as to apply the adhesive to the board edge. In the preferred form, surface 52 can be knurled so that the viscous liquid adhesive will be carried up from the reservoir into contact with board edge 27. In

conventional edge banding apparatus, roller applicators have peripheral glue applying surfaces which are vertically oriented. Adhesive 54 typically will be a heat activated adhesive, such as JOWAT brand hot melt glue, which comes in a granular form but turns into a viscous liquid at high temperatures, for example, 200°-250°C. Thus, on vertically oriented prior art roller applicator surfaces, there is a tendency for the viscous liquid adhesive to slump or run off of the vertical wheel, with the result that the upper portion of the board edge to which glue is being applied can have insufficient or even missing adhesive. This can be exacerbated by the vertical orientation of the board edge. In the orientation of roller applicator 51 as shown in FIGURE 3, however, adhesive can be readily carried up by roller surface 52 onto edge 27 in a manner which is uniform across the width of edge 27. Thus, prior art mechanisms for insuring uniform adhesive distribution on the applicator roller are not required in the present invention as a result of the near horizontal orientation of roller 51 and the near horizontal orientation of board edge 27.

Moreover, adhesive applying assembly 23 of the present invention is formed in a manner which provides greater flexibility in selection and changing of the adhesive being used. In prior art systems, the heating element for the adhesive often is mounted in the adhesive reservoir 56. In the present invention, a heating plate 61 can be positioned under reservoir 56, with the reservoir merely removably sitting on top of heating plate 61. Thus, it is a simple matter to remove reservoir 56 from heating plate 61, for example, to replace the reservoir 56 with another reservoir containing an adhesive having a different color. Various adhesive colors are employed since on certain edges the adhesive color may be minutely visible. In edge banding

apparatus having a heating element emersed in the adhesive in the reservoir, changing adhesive color is much more difficult.

It is also a feature of the present invention that adhesive reservoir 56 is relatively small, for example, about 10-20 cubic inches. This enables the relatively small volume of adhesive in reservoir 56 to be rapidly heated at start up and provides for a shorter residence time of the adhesive in the reservoir for less heat degradation.

Returning now to FIGURE 1, it will be seen that adhesive reservoir 56 and heating plate 61 are immediately in advance of banding material applying assembly 24. It would also be possible to put a plurality of adhesive applying assemblies 23 sequentially along support surface 34 in advance of banding material applying assembly 24. This would allow adhesives of various colors to be available to the operator without replacement of adhesive reservoirs 56. The operator would simply selectively turn "on" the heating plate 61 of a selected reservoir so as to cause the solid adhesive of the desired color to liquify and be carried up on an applicator roller 51 to the edge 27 of board 26. The small size of reservoir 56 enables a plurality of reservoirs to be used.

Downstream of adhesive applicator assembly 23 is a banding material applying assembly 24. As used herein, "downstream" means in the direction of arrow 33 so that after adhesive 54 has been applied to edge 27 of the board, then banding material 28 can be applied to edge 27 over adhesive 54. In the preferred form, banding material applicator 24 can be provided by a roll 41 of veneer or banding material 28 which is fed up over an applicator roller 62 so as to press the banding material against the adhesive-carrying edge 27 of board 26.

5 Additional pressing rollers 42 downstream of roller 62 project through surface 36 and use the weight of board 26 to press banding material 28 against the hot adhesive applied to edge 27. Both roll 41 and roller 62 are shown as idler or unpowered rollers, but it will be understood that they could also be powered in coordination with movement of board 26 along structure 22.

10 Alternatively, it would also be possible to support board 26 in a near vertical orientation on support structure 22 and move adhesive applying assembly 23 and banding material applying assembly 24 relative to board 26. This could be accomplished by placing assemblies 23 and 24 on a common carriage and moving the carriage in a direction opposite to arrow 33 along edge banding apparatus 21 underneath downwardly facing edge 27. Thus, 15 only relative motion between edge 27 and the adhesive applying and banding material applying assemblies is required within the broadest aspect of the present invention. One could even move both the board and the adhesive and banding applying assemblies to produce 20 relative motion.

25 One of the constant problems which has been encountered in connection with prior art edge banding apparatus has been the problem of trying to automate refilling of adhesive reservoir 56. The edge banding apparatus of the present invention includes a level sensor which is particularly well suited for sensing the level of viscous liquids, such as heat-activated adhesives, as well as 30 an adhesive dispenser which can be coupled to the level sensor and employed to periodically refill reservoir 56 with adhesive granules.

Referring now to FIGURE 3, a level sensing apparatus 71 is shown which is suitable for sensing the level of a viscous liquid, such as an adhesive, in a liquid

reservoir. While various adhesive level sensing devices would be suitable for use in the edge banding apparatus of the present invention, including, e.g., optical, ultrasonic mechanical and pressure sensors, the present 5 level sensing apparatus is pneumatically based. Level sensor 71 includes a source of gas under pressure 72 (FIGURE 2), which can be a part of apparatus 21 or a compressed gas source, such as compressed air source, of the wood working or furniture manufacturing facility 10 in which the present apparatus is operated. A conduit 73 extends from source 72 to a pneumatic controller 74. Controller 74 includes pneumatic valve assembly and two output conduits 76 and 77. Output conduit 76 acts as a gas discharge conduit mounted for discharge of 15 pressurized gas into viscous adhesive liquid 54 at a position below the top surface 78 of the adhesive. A pressure sensor 79 is coupled by conduit 81 to the gas discharge conduit 76 so as to enable sensing of the pressure in the gas discharge conduit. Controller 74 20 preferably is a combination of pneumatic valves and electronic control circuitry which can be used to control the discharge of gas into the viscous liquid, such as adhesive 54. Thus, the controller opens a pneumatic valve coupling the gas source 72 to gas discharge conduit 25 76 and gas is discharged from an end 82 of conduit 76 into viscous liquid 54. As gas is discharged, bubbles are produced in the viscous liquid and pressure variations occur in conduit 76, which are sensed and communicated electrically through electrical cable 83 30 back to the controller 74.

When the level of viscous liquid adhesive 54 in reservoir 56 is high, the bubbles formed by gas discharge will take a longer period of time to form. As the liquid level drops, bubbles are formed more quickly and migrate up 35 through the viscous liquid so as to permit more gas to pass out the end 82 of the gas discharge conduit. Thus

pressure fluctuations at pressure gauge 79 are more rapid as the level of viscous liquid in reservoir 54 drops. Controller 74 can monitor the pressure fluctuations at gauge 79 so as to sense when reservoir 56 is relatively 5 full and when it is relatively empty. This in turn allows predetermined rates of bubble discharge into the viscous liquid to be used as a sensor for determining when more adhesive should be added to reservoir 56. As 10 the adhesive is added, the rate of the bubbles will slow until it has reached a second discharge rate which can be used or indicates that the reservoir is sufficiently full that further adhesive does not need to be added to reservoir 56.

Controller 74, therefore, will respond to sensed gas 15 pressure discharge through conduit 76 so as to turn "on" and "off" pneumatic valving which, in turn, is used to dispense more adhesive into reservoir 56 in a manner which can be described by reference to FIGURE 4. In FIGURE 4, a pneumatic granule dispenser is shown which 20 can be used in connection with level sensors 71. Conduit 77 is connected from gas source 72 through controller 74 to the bottom of a granule reservoir 91. A plurality of adhesive granules 92 may be placed in reservoir 91, and conduit 77 acts as a gas stream forming conduit which 25 blows a stream of gas into a granule discharge conduit 94.

As gas is discharged from the stream forming conduit 77 into the spaced granule discharge conduit, granules 92 are pulled into the discharge conduit 94 and become 30 entrained in the stream of gases flowing into the discharge conduit. By placing the end of conduit 77 proximate the bottom of reservoir 91, the stream of gases discharged therefrom both stirs the adhesive granules and causes them to become entrained and blown into 35 conduit 94. The stream of gas further acts as a

conveying force which causes the granules to be pushed along conduit 94 and eventually into reservoir 76. As will be seen from FIGURE 4, it is preferred that the granule discharge conduit 94 be larger in diameter than the stream forming conduit 97, but there are several configurations which could be used in the present invention to pneumatically convey granules from granule reservoir 91 to liquid adhesive reservoir 56.

In the preferred form, the gas discharge conduit 94 can be a rubber or plastic conduit, but since reservoir 56 is heated, the end 94a of conduit 94 proximate reservoir 56 desirably is formed of a metal which can withstand high temperatures. Obviously, the entire granule discharge conduit 94 could be a metal conduit.

Other configurations are suitable for entraining granules pneumatically and conveying or transporting them to reservoir 56. Thus, a horizontally oriented stream forming conduit could be surrounded by the granule discharge conduit, with an upwardly facing opening in the granule discharge conduit so that adhesive granules could gravitate and/or be pneumatically pulled into the granule discharge conduit by the stream of gas. Moreover, granules can be pneumatically fed into reservoir 56 in measured amounts in response to level sensor 71 or in a continuous, unmeasured manner controlled by sensor 71. It also will be understood that level sensor 71 could be used to drive other granular adhesive feed assemblies, such as an auger, conveyor, etc.

While a scissors type or guillotine type rough trim or banding material cutoff device could be used with edge banding assembly 21, cutoff device 25 is preferably constructed in a manner which provides enhanced safety over such prior art rough trimmers. Just downstream of

banding material applying assembly 24 can be cutoff device 25. Thus, an opening 101, formed in horizontal surface 36, allows a blade mounting bar 102 to be mounted close to, but preferably below, the plane of surface 36. 5 Mounted on bar 102 is a blade or knife member 103 presenting a sharp edge 104 facing in a direction opposed to the direction of advancement of board 26 on support structure 22.

10 Oriented at an angle, preferably at about 90°, to blade 103 is a disk 106 having a relatively sharp edge 107 which rollingly engages and passes down across knife edge 104. Disk 106 is rotatably attached, but not powered, at axle 108 to a guard member 109, which can be displaced through an opening 111 in board support wall 31.

15 In order to move cutoff device 25 outwardly across surface 36 in the direction of arrow 112, an actuator, for example a pneumatic actuator including a cylinder 113 and displaceable piston 114, can be attached by yoke 116 to guard number 109. Compressed gas may be supplied by conduit 117 through pneumatic controller 74 from gas 20 source 72 (FIGURE 2) in order to power actuator 113, 114. Guided travel of guard member 109 across slot 101 can be provided by a guide track 118.

25 In operation, cutoff assembly 25 cuts or rough trims edge banding material 28, which has been applied to board 26, as follows. As board 26 is advanced in the direction of arrow 33, the board encounters a limit switch 121 (FIGURE 1) which is moved inwardly to wall 31 and which is electrically coupled to and signals controller 74 that 30 a board is present and being edge banded. When end 63 of board 26 passes beyond switch 121, the switch is biased outwardly and it signals pneumatic controller 74 to power pneumatic actuator 113, 114.

Guard member 109 and disk 105 are then rapidly displaced outwardly of wall 31 along track 118, causing edge 107 of the disk to rollingly move out along, and in engagement with, blade edge 104. The sharp blade edge 104 and edge 107 of the disk cooperate to cutoff banding material 28 behind board 26, with the cut being made closely proximate end 63 of the board. This is intended, however, only to be a rough trim cut which is to be followed up by a separate final trim of the edge banding material.

It will be seen from FIGURE 5 that, as guard member 109 moves outwardly, a front edge 122 of guard 109 precedes disk 106, that is, edge 122 extends transversely (in the direction of arrow 112) beyond disk 106. Thus, an operator's finger or hand will be pushed outwardly in the direction of arrow 112 away from the pinch point 123 at which edge band material 28 is being cut. Moreover, disk 106 will not tend to draw a finger or the like inwardly to pinch point 123, particularly since it is not powered for rotation.

Once the full stroke of actuator 113, 114 is completed, the actuator is retracted and guard member 109 and disk 106 are returned through opening 111 to a recessed position in wall 31 allowing the next board 26 to pass beyond cutoff assembly 25 during edge banding.

Having described the apparatus of the present invention, the method of adhesively securing the banding material to the edge of the board can be set forth. The first step in the present method is to orient the board to be banded 26 in a near vertical plane for application of a banding material to a downwardly facing edge 27 thereof. Next, the step of applying adhesive to the downwardly facing edge is accomplished by moving one of the adhesive applicator 23 and board 26. As above noted,

in the preferred form, board 26 is moved over adhesive applicator 23, but the applicator can also be moved relative to a stationary board. Thereafter, the present method includes the step of applying banding material 28 to downwardly facing edge 27 over the applied adhesive. Finally, after the banding material is applied, it is pressed against edge 27, for example, by pressing rollers 42 which make use of the weight of board 26, which weight is concentrated by reason of the vertical orientation of board 26. In the present method, the step of applying adhesive to edge 27 preferably is accomplished by a roller applicator 51 having a generally horizontally oriented adhesive applying peripheral surface 52. Applicator 51 evenly coats edge 27 without preferential slumping or gravitation of the adhesive to a lower side of edge 27.

In another aspect of the present invention, a method of sensing the level of viscous liquids, such as adhesive 54, is provided. The method is comprised of the steps of discharging gas into liquid adhesive 54 at a position below top surface 78 to produce bubbles in the viscous liquid. The rate of gas discharge into the viscous liquid is then determined and used to control the discharge of more adhesive into the reservoir in which the level is being sensed.

Finally, the method of the present invention includes replenishing adhesive in a reservoir which is comprised of the step of sensing the level of adhesive in the reservoir 56, for example, by using a pneumatic sensor 71. Upon sensing a predetermined adhesive level, granular adhesive is dispensed into reservoir 56 using a stream of gas to entrain the adhesive and transport it to the adhesive reservoir 56. This most preferably is accomplished by discharging the gas into a vertical stream at the bottom of a granule reservoir and into a

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granule transport and discharge conduit 94 spaced vertically from a stream forming conduit 77.

WHAT IS CLAIMED IS:

1. An edge banding apparatus for adhesively securing a banding material to an edge of a board comprising:
 - 5 a board support structure formed to support a board to be edge-banded in a near vertical orientation with an edge of said board in a downwardly facing orientation;
 - 10 an adhesive applying assembly positioned relative to said board support structure and formed to apply adhesive to said edge during relative motion between said board and said adhesive applying assembly; and
 - 15 a banding material applying assembly positioned downstream of said adhesive applying assembly and formed to apply a banding material to said edge after said adhesive is applied to said edge during relative movement between said board and said banding material applying assembly.
2. The edge banding apparatus of claim 1 wherein, said board supporting structure is formed for support of said board during movement of said board thereon with said edge in a substantially horizontal plane to pass over both said adhesive applying assembly and said banding material supplying assembly.
- 20 3. The edge banding apparatus of claim 1 wherein, said board supporting board from a vertical plane by an amount in the range of about 3° to about 10° toward board supporting surfaces, said board supportive surfaces being formed for sliding support of said board during movement along said board supporting structure and being formed to cause the weight of said board to bear upon said banding material after said banding material has been applied to said edge.
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4. The edge banding apparatus of claim 1 wherein,
said adhesive applying assembly includes an
applicator roller oriented to rotate about a near
horizontal axis and having an adhesive applying
5 peripheral surface positioned to rollingly engage said
edge during movement of said board.
5. The edge banding apparatus of claim 4 wherein,
said applicator roller is mounted in an adhesive
10 reservoir for rotation of said peripheral surface into
and out of an adhesive material contained in said
reservoir.
6. The edge banding apparatus of claim 5 wherein,
said adhesive applying assembly includes a heater
15 positioned to heat adhesive contained in said adhesive
reservoir, said adhesive reservoir having a relatively
small volume and being removably mounted on said heater.
7. The edge banding apparatus of claim 1 wherein,
said adhesive applying assembly includes an adhesive
20 reservoir, an applicator device for applying adhesive
in said reservoir to said edge of said board, and a
reservoir refilling assembly.
8. The edge banding apparatus of claim 7 wherein,
said reservoir refilling assembly includes an
25 adhesive level sensor positioned to sense the level of
adhesive in said reservoir, and an adhesive dispenser
responsive to said level sensor to refill said reservoir
with adhesive when said sensor determines that the level
of adhesive is below a predetermined level.
9. The edge banding apparatus of claim 8 wherein,
30 said level sensor is provided by a gas discharge
assembly positioned to discharge a gas into said adhesive
below a top surface of said adhesive to produce bubbles

therein and a pressure sensor formed to sense the rate of discharge of gas into said adhesive.

10. The edge banding apparatus of claim 7 wherein, said reservoir refilling assembly includes a
5 granular adhesive dispenser.

11. The edge banding apparatus of claim 10 wherein, said granular adhesive dispenser is provided by a pneumatic dispenser device formed to transport granules of adhesive from a granule reservoir to said adhesive reservoir by pulling granules into a granule dispensing conduit using a stream of a gas.
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12. The edge banding apparatus of claim 2 wherein, said adhesive applying assembly includes an applicator roller mounted in said adhesive reservoir and formed with a near horizontally oriented peripheral surface positioned to be partially immersed in a liquid adhesive in said adhesive reservoir and positioned to rollingly engage said edge, said adhesive applying assembly further including an adhesive level sensor
15 formed to discharge a gas below the surface of said liquid adhesive in said adhesive reservoir and formed to sense the rate of gas discharged into said liquid adhesive, and said adhesive applying assembly including pneumatically powered granular adhesive dispenser coupled
20 and responsive to said adhesive level sensor to pneumatically discharge adhesive granules into said adhesive reservoir upon sensing of a predetermined rate of gas discharge into said liquid adhesive.
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13. The edge banding apparatus of claim 1 wherein,
30 said banding material applying assembly is provided by a roll of banding material rotatably mounted proximate said adhesive applying assembly and a roller mounted to press said banding material against said edge.

14. The edge banding apparatus of claim 1, and a banding material cutoff assembly positioned proximate and downstream of said banding material applying assembly, said cutoff assembly being formed to sense an aft end of said board and to automatically cutoff said banding material upon passage of said aft end beyond said cutoff assembly.

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15. The edge banding apparatus of claim 14 wherein, said cutoff assembly includes a knife edge and a disk having an edge mounted to cooperatively engage said knife edge to cut said banding material.

10

16. The edge banding apparatus of claim 15 wherein, said disk is mounted for rotation to a support member, and said support member is mounted for translation along said knife edge for rotating translational engagement with said knife edge.

15

17. The edge banding apparatus of claim 16 wherein, said support member is provided by a guard member formed to project outwardly beyond said disk in a direction of translation of said disk member along said knife edge during cutting.

20

18. The banding apparatus of claim 17 wherein, said knife edge is mounted below and proximate said edge as supported for edge banding, said knife edge facing in a direction opposed to movement of said board during edge banding, said disk edge is facing in the direction of movement of said board during edge banding, and said guard member is on a side of said disk facing away from said board when said board passes said disk.

25

30 19. A level sensing apparatus for sensing the level of a viscous liquid in a liquid reservoir comprising:
a source of gas under pressure;

a gas discharge conduit connected to said source of gas and mounted for discharge of pressurized gas into said viscous liquid at a level below a top surface of said viscous liquid; and

5 a gas flow rate sensor coupled to sense the rate of gas discharged into said viscous liquid.

20. The level sensing apparatus of claim 19 wherein, said gas flow rate sensor is comprised of a pressure sensor coupled to a pulse sensor formed to count the rate 10 at which bubbles are formed in the viscous liquid upon discharge of gas therein.

21. The level sensing apparatus of claim 20, and wherein, 15 said viscous liquid is provided by a liquid adhesive.

22. A granule dispenser comprising:
a source of gas under pressure;
a granule of granules positioned in said reservoir;
a granule discharge conduit proximate said granule 20 reservoir; and
a gas stream forming conduit connected to receive gas from said source of gas and formed to discharge gas in a stream past granules in said reservoir and into said granule discharge conduit so as to pull granules from 25 said reservoir into said granule discharge conduit.

23. The granule dispenser of claim 22 wherein, said granules are heat-activatable adhesive granules.

24. The granule dispenser of claim 22 wherein, 30 said granule discharge conduit has an open input end positioned in said granule reservoir; and

said gas stream forming conduit has a stream forming end thereon positioned in said granule reservoir and spaced from said input end of said granule discharge conduit.

5 25. The granule dispenser of claim 24 wherein,
said open end of said granule discharge conduit is
larger than said stream forming end of said gas stream
forming conduit.

10 26. The granule dispenser of claim 25 wherein,
said granule discharge conduit is substantially
vertically oriented with said open input end facing
downwardly; and
said stream forming end is positioned below, aligned
with and in spaced relation to said open input end.

15 27. A cutoff device for cutting sheet material
comprising:
a knife blade having a knife edge;
a disk rotatably mounted to a support member and
having a disk edge rotatably engaging and passing across
20 said knife edge at a pinch point in a plane intersecting
a plane of said knife edge;
an actuator assembly coupled to one of the knife
blade and the support member and formed to produce
relative displacement between the said knife blade and
25 said disk to move said pinch point along said knife edge
to cause said knife edge and said disk edge to
cooperatively cut a sheet of material positioned to be
engaged thereby at said pinch point.

30 28. The cutoff device of claim 27 wherein,
said knife blade is stationary; and
said actuator assembly is formed to displace said
disk along said knife blade.

29. The cutoff device of claim 27 wherein,
said disk is an unpowered idler disk.
30. The cutoff device of claim 27 wherein,
said support member is provided as a guard member
5 extending outwardly of said disk in a direction in
advance of cutting of said sheet material.
31. The cutoff device of claim 27, and
a sheet support surface mounted proximate and in
a plane substantially parallel to a plane of said knife
10 blade and formed to support said sheet during cutting.
32. The cutoff device of claim 27 wherein,
said actuator assembly includes a sensing device
positioned to sense the position of said sheet relative
to said cutoff device and responsive thereto to produce
15 relative displacement.
33. The cutoff device of claim 27 wherein,
said knife blade and said disk are oriented in
planes intersecting at about 90°.
34. A method of adhesively securing banding material
20 to an edge of a board comprising the steps of:
orienting said board to be banded in a near vertical
plane for application of banding material to a downwardly
facing edge thereof;
applying adhesive to said downwardly facing edge
25 of said board by moving one of an adhesive applicator
and said board;
thereafter applying a banding material to said
downwardly facing edge over the applied adhesive; and
thereafter pressing said banding material against
30 said edge.
35. The method of claim 34 wherein,

5 said pressing step is accomplished by supporting said banding material while on said downwardly facing edge on a support surface so that the weight of said board is applied to press said banding material against said edge.

10 36. The method of claim 34 wherein,
 said step of applying adhesive is accomplished by rolling adhesive on said downwardly facing edge using a roller having a near horizontally oriented adhesive applying surface.

15 37. The method of claim 34 wherein,
 said step of applying adhesive is accomplished by moving said board over said adhesive applicator and over a banding material applying assembly.

20 38. A method of sensing the level of a viscous liquid in a liquid reservoir comprising the steps of:
 discharging a gas into said liquid at a position below a top surface of said liquid to produce bubbles in said liquid; and
 determining the rate of gas discharge into said liquid.

25 39. The method of claim 38 wherein,
 said discharging step is accomplished by discharging said gas from an open ended conduit extending to a position below said top surface; and
 said determining step is accomplished by measuring the pressure of said gas in said conduit.

30 40. The method of claim 38 wherein,
 said discharging step is accomplished by discharging said gas into a viscous liquid adhesive.

41. The method of claim 40 wherein,

said discharging step is accomplished by discharging one of air and an inert gas into said liquid adhesive.

42. A method of replenishing an adhesive reservoir having a heated liquid adhesive therein comprising the 5 steps of:

sensing the level of adhesive in said adhesive reservoir; and

10 upon sensing a predetermined adhesive level, dispensing granular adhesive into said adhesive reservoir using a stream of a gas to entrain said granular adhesive in said stream of gas and transport said granular adhesive to said adhesive reservoir.

43. The method of claim 42 wherein, 15 said dispensing step is accomplished by discharging said stream of gas through a portion of a granular adhesive reservoir and into an adhesive transport conduit so as to pull granules from said granular adhesive reservoir.

44. The method of claim 43 wherein, 20 said discharging step is accomplished by vertically discharging said stream of gas proximate a bottom of said reservoir into an adhesive transport conduit spaced vertically in said adhesive reservoir to both mix said granules while in said granule reservoir and entrain 25 granules in said stream of gas entering said adhesive transport conduit.

45. The method of claim 42 wherein, 30 said sensing step is accomplished by discharging a gas into said liquid adhesive in said adhesive reservoir at a position below a top surface thereof, and determining the rate of discharge of said gas into said liquid adhesive.

-29-

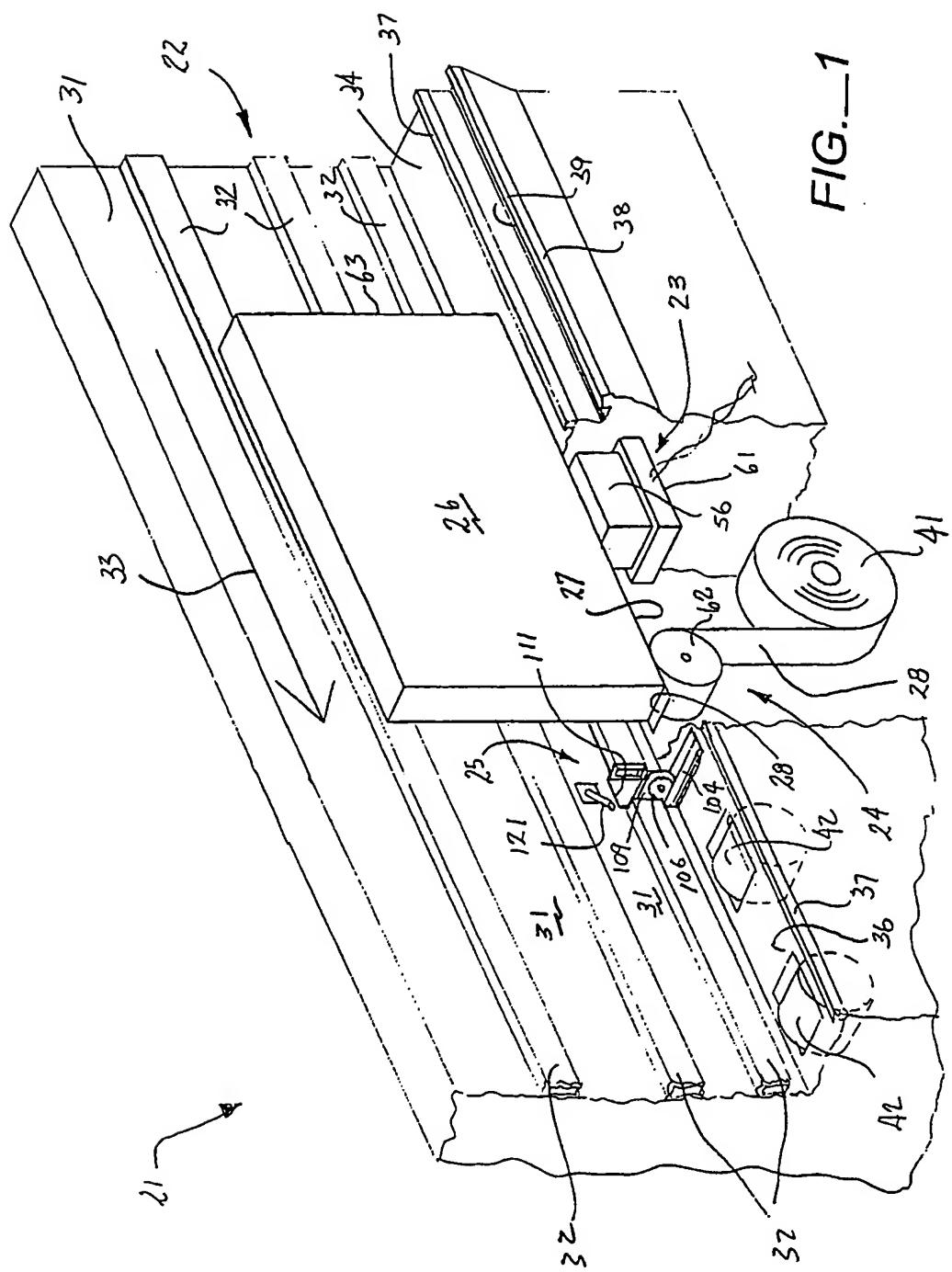
46. A method of cutting off a sheet of material comprising the steps of:

translating a rotatable disk edge along a stationary knife edge with said edges oriented in intersecting planes; and

5 prior to said passing step, positioning a sheet to be cut for movement of a pinch point between said knife edge and said disk edge across said sheet.

47. The method of claim 46 wherein,

10 said translating step includes moving a guard member with said disk edge to resist entry of objects into said pinch point.



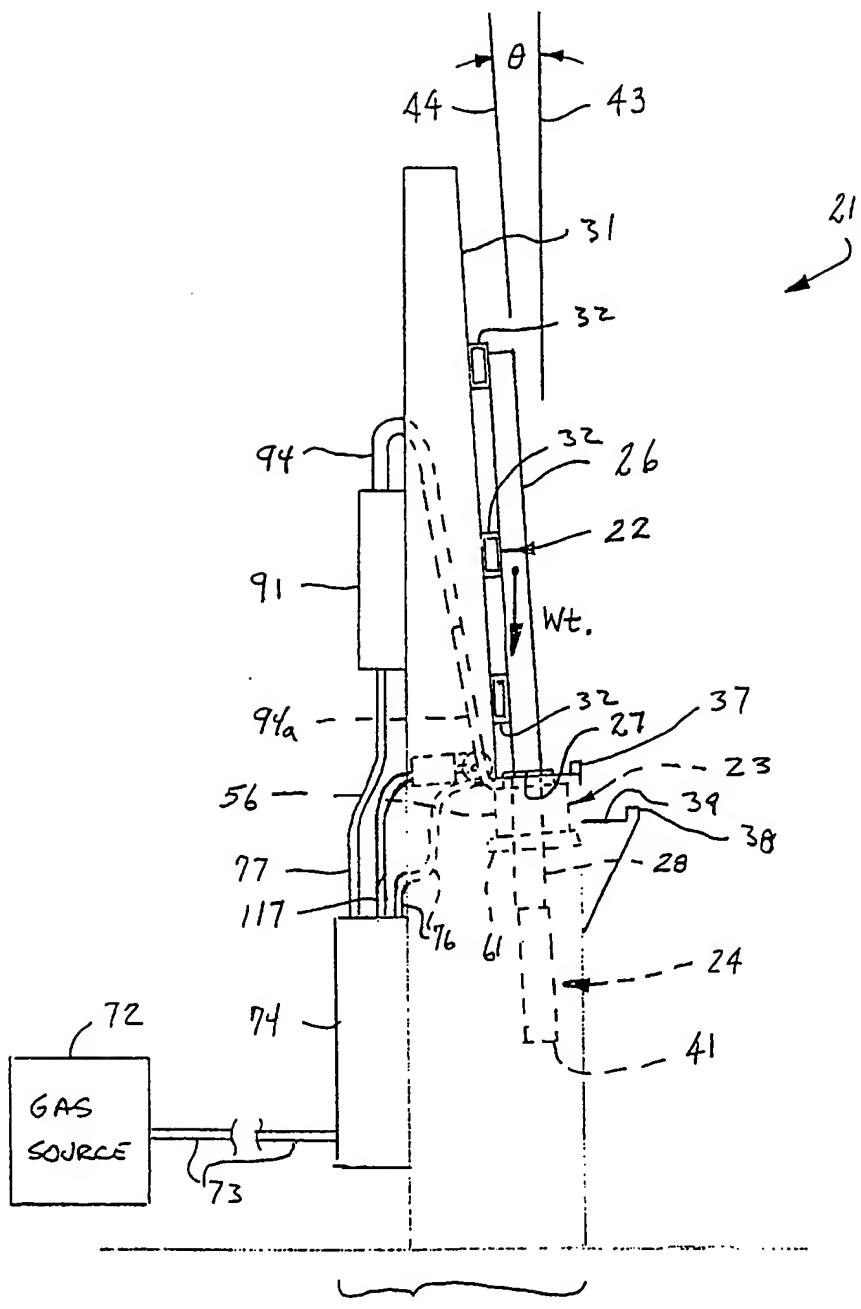


FIG. 2

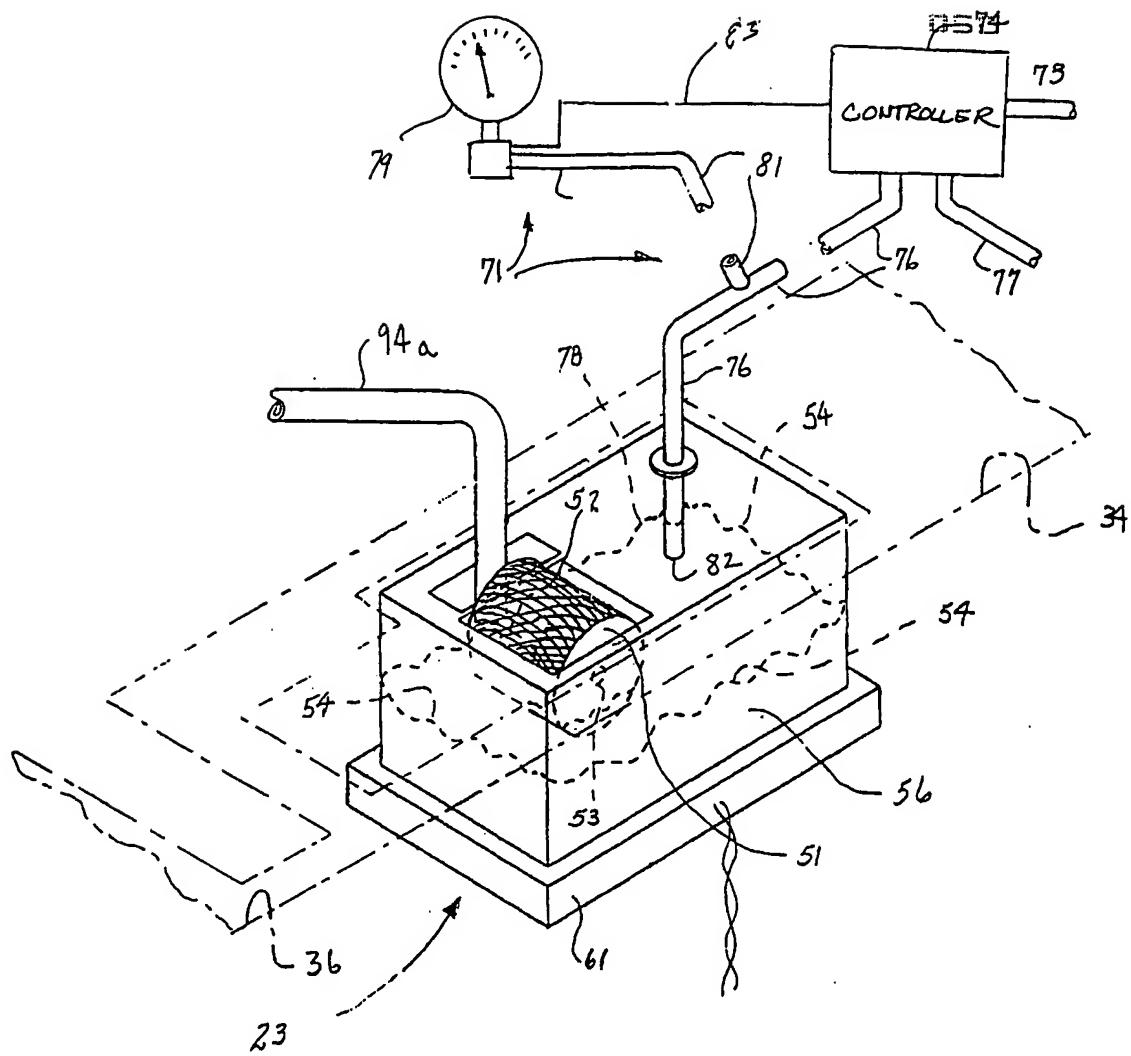


FIG. 3

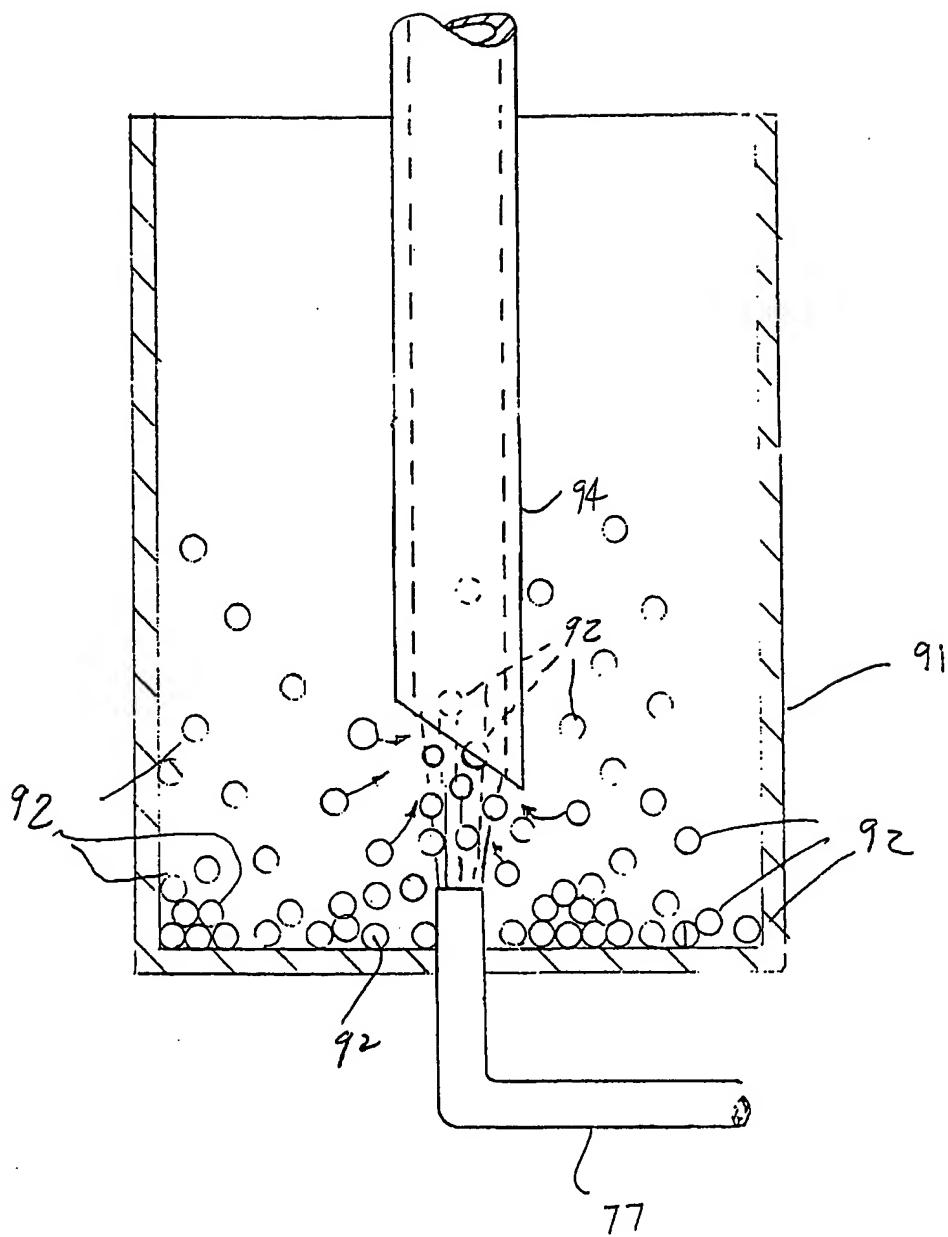


FIG. 4

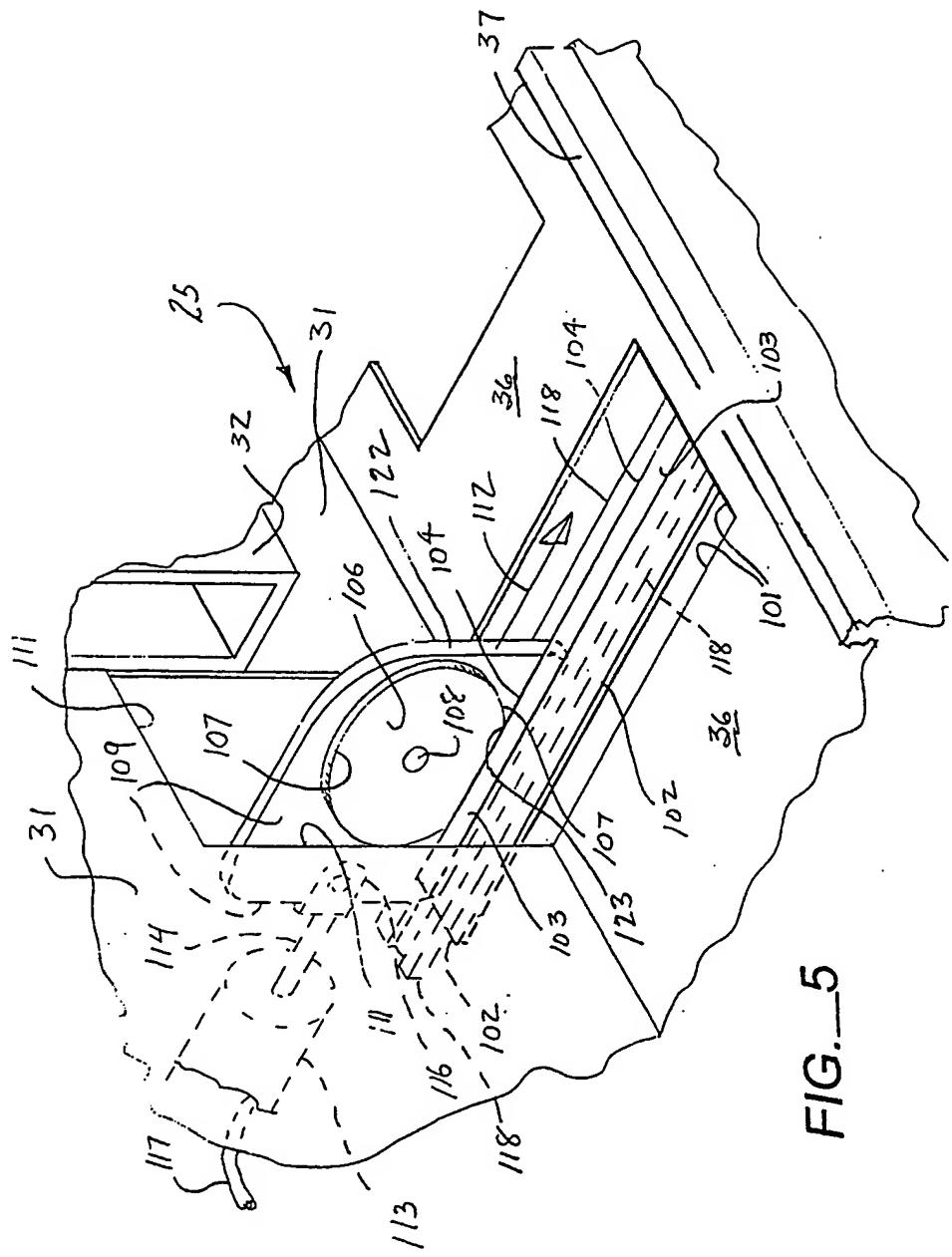


FIG. 5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US00/40501

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : B01F 3/04; B32B 31/00; B65H 29/00

US CL :Please See Extra Sheet.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 83/ 56, 471.2: 156/212, 250, 468, 486, 522, 523, 524; 221/1: 222/1. 3; 261/1,119.1

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
NONEElectronic data base consulted during the international search (name of data base and, where practicable, search terms used)
NONE

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|-----------|--|-----------------------|
| Y | UA 3,468,741 A (MILLER et al) 23 September 1969, entire document. | 1-18 and 34-37 |
| Y | US 3,473,988 A (RULLIER et al) 21 October 1969, entire document. | 1-18 and 34-37 |
| Y | US 3,700,140 A (HARVEY) 24 October 1972, entire document. | 22-26 and 42-45 |
| Y | US 3,927,152 A (KYRIAS) 16 December 1975, entire document. | 19-21 and 38-41 |
| Y | US 4,356,614 A (KAUFERLE, deceased et al) 2 November 1982, entire document. | 1-18 and 34-37 |
| Y | US 4,561,929 A (LENHARDT) 31 December 1985, entire document. | 1-18 and 34-37 |

 Further documents are listed in the continuation of Box C. See patent family annex.

| | |
|--|--|
| Special categories of cited documents: | |
| "A" | document defining the general state of the art which is not considered to be of particular relevance |
| "E" | earlier document published on or after the international filing date |
| "L" | document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) |
| "O" | document referring to an oral disclosure, use, exhibition or other means |
| "P" | document published prior to the international filing date but later than the priority date claimed |
| "T" | later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention |
| "X" | document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone |
| "Y" | document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art |
| "&" | document member of the same patent family |

Date of the actual completion of the international search
11 OCTOBER 2000Date of mailing of the international search report
14 NOV 2000Name and mailing address of the ISA/US
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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US00/40501

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|-----------|--|-----------------------|
| Y | US 4,708,762 A (LENHARDT) 24 November 1987, entire document. | 1-18 and 34-37 |
| Y | US 4,769,105 A (LISEC) 06 September 1988, entire document. | 1-18 and 34-37 |
| Y | US 5,433,818 A (LEE) 18 July 1995, entire document. | 1-18 and 34-37 |
| Y | US 5,902,448 A (STETTNER) 11 May 1999, entire document. | 27-33 and 46-47 |
| Y | WO 97/15816 A1 (TAKEI et al) 01 May 1997, entire document. | 22-26 and 42-45 |

INTERNATIONAL SEARCH REPORT

| |
|---|
| International application No. PCT/US00/40501 |
|---|

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This international report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

Please See Extra Sheet.

1. As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

The additional search fees were accompanied by the applicant's protest.
 No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

| |
|---|
| International application No. PCT/US00/40501 |
|---|

A. CLASSIFICATION OF SUBJECT MATTER:
US CL :

83/ 56, 471.2; 156/212, 250, 468, 486, 522, 523, 524; 221/I; 222/I, 3; 261/I, 119.1

BOX II. OBSERVATIONS WHERE UNITY OF INVENTION WAS LACKING
This ISA found multiple inventions as follows:

This application contains the following inventions or groups of inventions which are not so linked as to form a single inventive concept under PCT Rule 13.1. In order for all inventions to be searched, the appropriate additional search fees must be paid.

Group I, claim(s)1-18 and 34-37, drawn to apparatus and method for applying material to the edge of a substrate.

Group II, claim(s) 19-21, drawn to a level sensor apparatus and method.

Group III, claim(s) 22-26, drawn to a dispenser apparatus and method.

Group IV, claims 27-33 and 46-47, drawn to cutter apparatus and method.

The inventions listed as Groups I, II, III, and IV do not relate to a single inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons: the technical feature of applying a material to the edge of a substrate.